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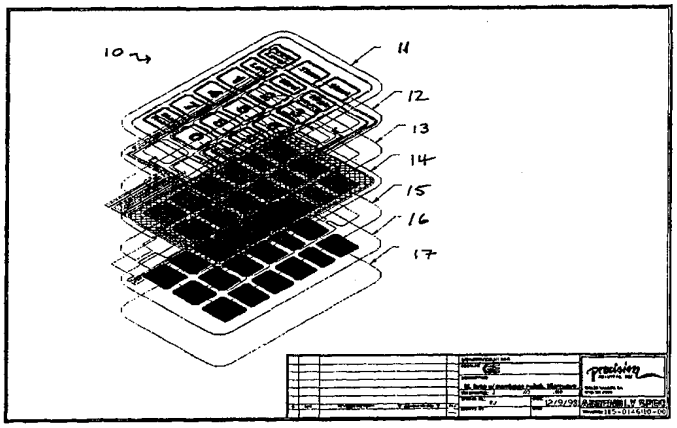

(57) Abstract

The patent discloses a membrane–style touch switch assembly (10) for controlling a device, the membrane–style touch switch including electroluminescent lighting (12) and being adapted to lead a person through a logical control sequence for control of the associated device. The touch switch assembly comprises a lower substrate (16) with one or more lower conductive elements, a spacer (15) which defines one or more apertures which are aligned with the lower conductive elements, an upper substrate (14) which has one or more upper conductive elements mounted or printed thereon, the upper conductive elements being adapted to be aligned with the apertures (61) in the spacer (15), an indicator layer (11) including indicator points, an electroluminescent layer (12) which illuminates one or more indicator points and a controller adapted to control the electrolumiates one or more indicator points and a controller adapted to control the electroluminescent layer such that the indicator points are illuminated in a sequence. The patent also discloses methods for making the membrane–style touch switch assembly and methods for leading an individual through a logical sequence to control a device associated with the touch switch assembly.

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ELECTROLUMINESCENT TOUCH SWITCH

Background of Invention

A membrane-style touch switch assembly is commonly used in applications where a user is selecting the function for a piece of electrical equipment. The touch switch assembly operates such that the exertion of a light mechanical force on an indicator point is sufficient to complete a specific electric circuit. Completion of the electric circuit in turn controls the electrical equipment in the manner directed as signified by the indicator point.

In general the construction of a membrane-style touch switch includes a lower substrate with one or more conductors mounted or printed on it. A spacer with apertures separates the lower substrate and conductors from an upper flexible substrate, which also has conductors mounted or printed on it. The upper conductors are each aligned with a corresponding lower conductor. The upper and lower conductors are separated by an air gap, which corresponds to one of the apertures in the spacer. Typically an indicator layer with graphics is mounted on the upper flexible substrate. Frequently the graphics signify touch keys or indicator points, which are aligned with the upper and lower conductors. The indicator points can specify particular functions of the electrical appliance. Pressure applied to the indicator layer on an indicator point and therefore to the upper flexible substrate will act to push an upper conductor and a corresponding lower conductor together. This contact closes an electric circuit, which produces the specified function from the appliance.

Recently light emitting diodes (LEDs) have been introduced to membrane-style touch switches. LEDs were introduced in the interest of making the graphical displays more instructional and user-friendly. An LED can be associated with a specific indicator point and mounted to the indicator layer or within the air gap. The touch switch assembly can be programmed so that the LED illuminates an individual indicator point or a group of indicator points to indicate to a user how to proceed in keying commands into the appliance.

The difficulties with the use of LEDs in membrane-style touch switch assemblies is that the can add significant manufacturing restraints. The use of LEDs in the switch assembly means that some bulk is necessarily added to the assembly. While electroluminescent lamps are flat, LEDs require wiring and fixturing. In addition, LEDs can be damaged or broken by the pressure applied in membrane-style touch switches. Further the production of membrane touch switch assemblies which include LEDs can be costly.

Summary of the Invention

The present invention is directed to a membrane-style touch switch assembly with an integrated electroluminescent lamp layer. The invention is particularly directed to the use of electroluminescent lamps in membrane-style touch switch assemblies to provide a display which is instructional and user friendly by providing illumination designed to lead a user through the process of operating the equipment associated with the touch switch.

Broadly, the assembly includes a lower substrate, which has conductive elements printed or mounted thereon. A spacer, which defines several apertures, is attached with the lower substrate. Each of the apertures is aligned with a conductive element. A flexible upper substrate with conductive elements printed on its lower side is attached with the spacer. When the upper substrate is attached with the spacer the upper conductive elements are aligned with the apertures and therefore with the lower conductive elements. The use of a spacer with apertures means there is an air gap between the upper conductive elements and the corresponding lower conductive elements.

A flexible electroluminescent layer is attached with the flexible upper substrate. A flexible indicator layer, which includes graphics, is attached to the flexible electroluminescent layer. The indicator layer defines specific indicator points. When pressure is applied by, for example, a fingertip to an indicator point, the indicator layer, electroluminescent layer and flexible upper substrate flex and the air gap between one of the upper and lower conductive elements is closed. This completes a circuit.

The electroluminescent lighting is designed such that one pixel is associated with one indicator point on an indicator layer, or one group of indicator points one the indicator layer. As such, a pixel in the electroluminescent lamp layer can be used to light a specified indicator point or group of indicator points. The electroluminescent layer is programmed to lead a user through the process necessary to use the appliance or equipment associated with the touch switch.

A digital circuit can be incorporated directly into the touch switch so that the logical control sequence for a particular application is highlighted for the person who is attempting to use the device. This delivers software-like menu control to the user, without resorting to putting a costly computer display into the device.

A significant benefit of using electroluminescent lighting to illuminate the membrane-style touch switch assembly is that the electroluminescent layer is flexible in itself. As a result very little space is required to include the lighting layer and it can be attached to the upper conductive substrate. The electroluminescent lighting will not be damaged by mechanical pressure causing it to flex. The membrane switch can be evenly illuminated while still having mechanical distortion capabilities.

Another benefit is in the cost of production. While LED lighting for a touch switch must be produced independently and then added to the membrane-style touch switch assembly, the electroluminescent layer and the touch switch assembly can be produced concurrently.

Brief Description of the Drawings:

The invention will be better understood by reference to the appended figures in which

Figure 1 shows an assembly of an embodiment of the electroluminescent membrane-style touch switch of the present invention showing all layers in exploded view.

Figure 2 shows a top view of an embodiment of the indicator layer, showing indicator points.

Figure 3 shows a dimensional drawing of an embodiment of the electroluminescent lamp layer.

Figure 4 shows a top view of an embodiment of an overlay adhesive layer.

Figure 5 shows a top view of an embodiment of the upper substrate with conductive elements.

Figure 6 shows a top view of an embodiment of the switch spacer.

Figure 7 shows a top view of an embodiment of the lower substrate with conductive elements

Figure 8 shows a top view of an embodiment of a mounting adhesive layer.

Figures 9 through 18 illustrate the touch switch illumination process for an embodiment of the invention.

Detailed Description of the Invention

The assembly and method of production for an embodiment of the invention are described in the following paragraphs and illustrated in the appended figures. In one embodiment, the membrane-style touch switch assembly comprises multiple layers.

Lower substrate

The lower substrate 16 is shown in Fig. 7. It is typically composed of heat stabilized polyester or a similar material. The temperatures usually utilized for the manufacture of electroluminescent lamps means that heat stabilized materials are useful in this layer. A number of conductive elements 71 are printed on the top side of the lower substrate 16 with conductive ink.

Spacer

The switch spacer 15, shown in Fig. 6, defines a number of apertures 61 such that each aperture 61 will lie over one of the conductive elements 71 on the lower substrate 16 once the switch spacer 15 lies across the lower substrate 16.

Upper substrate

The upper substrate 14 is illustrated in Fig. 5. It is a requirement that the upper substrate be flexible. It is typically composed of heat stabilized polyester or a similar material. A number of conductive elements 51 are printed on the bottom side of the upper substrate 14. The conductive elements 51 are printed such that when the upper substrate 14 lies over the spacer 15 and the lower substrate 16 each of the upper conductive elements 51 correspond to and are aligned with an aperture 61 in the spacer and therefore with a lower conductive element 71. Thus the upper and lower conductive elements are separated by the aperture in the spacer. Pressure on the flexible upper substrate 14 at the position of an upper conductive element 51 will bring that upper conductive element 51 into contact with a lower conductive element 71.

The top side of the upper substrate 14 can be printed with conductive ink in order to shield from electrostatic discharge.

Electroluminescent Lamp Layer

The electroluminescent lamp layer 12 is shown in Fig. 3.

The electroluminescent lamp layer 12 is flexible. It is comprised of one or more typical planar electroluminescent lamps such as the one described in U.S. Application No. 08/910,724, entitled ELECTROLUMINESCENT LAMP DESIGNS which is commonly owned by the assignee of the subject application and incorporated herein by reference.

One type of lamp which can be used is the laminar style lamp as described in U.S. Application No. 08/910,724. Generally, these laminar style lamps include first and second electrically conductive layers and an electroluminescent material disposed between the first and second conductive layers. In the present invention the first electrically conductive layer includes a plurality of openings separated by electrically conductive elements. The laminar style lamps may optionally include a translucent or transparent electrically conductive layer in electrical contact with the first conductive layer. In the embodiment that does not include the translucent or transparent electrically conductive layer, it is preferred that at least one of the openings in the first conductive layer has a minimum edge to edge distance of less than about 0.005 inches. In preferred embodiments of the invention, the first conductive layer includes rectangular or hexagonal shaped openings. In another preferred embodiment, at least a portion of one of the electrically conductive elements separating the openings in the first conductive layer has a width of less than about 0.002 inches. If the lamp includes a translucent or transparent electrically conductive material layer, it is preferred that this layer is made of particles of electrically conductive material suspended in a matrix.

Another embodiment of the invention could include one or more iso-planar lamps as described in U.S. Application No. 08/910,724. Such lamps include an electrically conductive layer divided into two or more electrically conductive elements by one or more channels. The lamps also include an electroluminescent material, which at least partially fills a portion of the one or more channels or at least partially covers a portion of the two or more electrically conductive elements. It is preferred that the iso-planar lamps include two conductive elements, which may be fabricated in a wide variety of shapes including inter-digitated comb-like structures, and circular and rectangular interleaved spiral structures.

The lamp layer 12 will typically comprise a plurality of independently addressable picture elements or pixels. Each pixel would be made to correspond to one set of upper and lower conductive elements and would be able to be independently controlled by, for example, a digital circuit, which can be incorporated directly into the touch switch. The digital circuit controls the electroluminescent lamp 12 in such a way that the logical control sequence for a particular application is highlighted for the person who is attempting to use the device.

Indicator layer

The indicator layer 11 is shown in Fig. 2. This layer is flexible and contains the graphics and icons that show a user how to control the appliance, for example. The graphics would vary according to the appliance or equipment associated with the touch switch. The indicator layer 11 graphically defines specific indicator points 21, which designate a particular command or function of the electrical equipment being controlled. Each indicator point 21 typically will correspond to one set of upper conductive elements 51 and lower conductive elements 71. Each pixel on the electroluminescent layer would typically be used to illuminate one indicator point 21. Thus one indicator point 21 or one group of indicator points 21 is illuminated to direct the user as to which indicator point 21 should be pressed. Pressure on the indicator point 21 causes the indicator layer 11 to flex at that point, further causing the electroluminescent layer 12 and the upper flexible substrate 14 to flex at that point, closing the air gap between an upper conductive element 51 and a lower conductive element 71 at that point and therefore closing the circuit.

The indicator layer 11 could alternately be printed directly onto the electroluminescent layer.

Adhesive layers

Adhesive can be used to fixedly attach the layers together and to mount the membrane-style touch switch on the electrical equipment.

Assembly

The assembly of the entire electroluminescent membrane-style touch switch is shown in Fig. 1. At the top the indicator layer 11 which graphically defines indicator points is attached with the electroluminescent layer 12. A layer of adhesive 13 attaches the electroluminescent

layer with the top side of the upper substrate 14. The spacer 15 layer lies between the lower side of the upper substrate 14 on which conductive elements 51 are printed or mounted, and the upper side of the lower substrate 16 on which conductive elements 71 are printed or mounted. Adhesive is used to mount the entire assembly to the electrical equipment it controls.

Instructional Aspect of Touch Switch

Figures 9 through 18 illustrate an embodiment of the touch switch showing a sequence for illuminating a touch switch designed for use in, for example, a factory. The shaded indicator points are not illuminated while the unshaded indicator points are illuminated. The sequence shown leads the user to hit 'Begin', Figure 9, and then enter the ID number of the part they are making in Figure 10. The process continues with the user entering the job number, Figure 11, the design, Figure 12, the material, Figure 13, the quantity, Figure 14, the color, Figure 15 and hitting start, Figure 16. In Figure 17, the equipment associated with the touch switch is in operation and the options available are stop and resume. Figure 18 shows the keypad after the process is completed.

Each touch switch and associated digital circuit can be designed in a way that reflects the functions that are relevant to controlling a particular application. For example, in a microwave key pad, upon the door being closed the electroluminescent layer would illuminate the power level button. Upon the power level button being pressed the electroluminescent layer would illuminate the power settings. Upon a power setting being selected the electroluminescent layer would illuminate the numbers to set a time. Upon the time being entered the electroluminescent layer would illuminate the start button which would start the microwave. A washing machine touch switch, for example, would have a different set of icons and a different sequence for the electroluminescent layer than, say, a microwave oven touch switch.

In a method for producing a membrane-style touch switch assembly the following steps are performed.

(i) printing one or more conductors on an upper side of a lower substrate 16;

(ii) printing one or more conductors on a lower side of an upper substrate such that each of the conductors on the upper substrate corresponds with a conductor on the lower substrate 16;

(iii) printing conductive ink on an upper side of the upper substrate;

(iv) sandwiching a spacer with apertures which correspond to the conductors on the upper substrate and the lower substrate 16 between the upper substrate and the lower substrate 16 such that every conductor on the upper substrate is separated from and aligned with a conductor on a lower substrate 16;

(v) positioning an electroluminescent layer composed of one or more independently addressable pixels on top of the upper side of the upper substrate such that each pixel corresponds to and is aligned with a conductor on the upper substrate and a conductor on the lower substrate 16;

(vi) positioning an indicator layer which includes designated indicator points above the electroluminescent layer such that each indicator point corresponds to and is aligned with a conductor on the lower layer and a conductor on the upper layer;

(vii) programming a digital circuit or other controller to control the electroluminescent layer in such a way as to highlight the logical control sequence for a particular application;

(viii) connecting the digital circuit or other controller with the membrane-style touch switch.

A method for guiding a person in utilizing a device associated with a touch switch is also encompassed by the invention. In an embodiment of the invnetion the method comprises connecting a membrane-style touch switch with the device. The membrane style touch switch is adapted to control the device and includes indicator points relating to the control of the device. The membrane-style touch switch further includes electroluminescent lighting, which corresponds to at least some of the indicator points. The method of this embodiment of the invention also comprises leading the person utilizing the device through a logical sequence for controlling the device. This is performed by illuminating the membrane-style touch switch using the electroluminescent lighting in such a manner as to illuminate the indicator points in the particular sequence the person would follow in performing the logical control sequence for the device.

The detailed description of the invention and the associated figures are intended to be illustrative only and do not define or limit the scope of the invention. The scope of the invention is defined by the appended claims and equivalents thereto.

We claim:

1. A membrane-style touch switch assembly comprising:

a lower substrate which has a bottom side and a top side, one or more lower conductive elements being mounted or printed on the top side of the lower substrate;

a spacer which defines one or more apertures which are adapted to be aligned with the lower conductive elements;

an upper substrate which has a bottom side and a top side, one or more upper conductive elements being mounted or printed on the bottom side of the upper substrate, the upper conductive elements being adapted to be aligned with the apertures in the spacer;

an indicator layer including indicator points;

an electroluminescent layer comprising one or more independently addressable pixels, each independently addressable pixel in the electroluminescent layer being adapted to illuminate one or more indicator points; and,

a controller adapted to control the electroluminescent layer such that the indicator points are illuminated in a sequence.

2. The membrane-style touch switch described in claim 1, wherein the controller is a digital circuit incorporated directly into the touch switch.

3. The membrane-style touch switch described in claim 1, wherein the touch switch is connected to a device and wherein the order in which the indicator points are illuminated highlights a logical control sequence the device.

4. The membrane-style touch switch described in claim 1, further comprising one or more adhesive layers.

5. The membrane-style touch switch described in claim 1, wherein the top side of the upper substrate is printed with conductive ink.

6. A membrane-style touch switch assembly comprising:

a lower substrate which has a bottom side and a top side, one or more lower conductive elements being mounted or printed on the top side of the lower substrate;

a spacer which defines one or more apertures which are adapted to be aligned with the lower conductive elements;

an upper substrate which has a bottom side and a top side, one or more upper conductive elements being mounted or printed on the bottom side of the upper substrate, the upper conductive elements being adapted to be aligned with the apertures in the spacer, conductive ink being printed on the top side of the upper substrate;

an indicator layer including indicator points;

an electroluminescent layer comprising one or more independently addressable pixels, each independently addressable pixel in the electroluminescent layer being adapted to illuminate one or more indicator points; and,

a digital circuit incorporated directly into the touch switch and adapted to control the electroluminescent layer such that the indicator points are illuminated in a sequence;

wherein the touch switch controls a device and wherein the sequence in which the indicator points are illuminated highlights a process for controlling the device.

7. A method for producing a membrane-style touch switch assembly comprising the steps of:

printing one or more conductors on an upper side of a lower substrate;

printing one or more conductors on a lower side of an upper substrate such that each of the conductors on the upper substrate corresponds with a conductor on the lower substrate;

printing conductive ink on an upper side of the upper substrate;

sandwiching a spacer with apertures which correspond to the conductors on the upper substrate and the lower substrate between the upper substrate and the lower substrate such that every conductor on the upper substrate is separated from and aligned with a conductor on a lower substrate;

positioning an electroluminescent layer composed of one or more independently addressable pixels on top of the upper side of the upper substrate such that each pixel corresponds to and is aligned with a conductor on the upper substrate and a conductor on the lower substrate;

positioning an indicator layer which includes designated indicator points above the electroluminescent layer such that each indicator point corresponds to and is aligned with a conductor on the lower layer and a conductor on the upper layer;

programming a controller to control the electroluminescent layer such that the electroluminescent layer illuminates selected indicator points in a sequence; and,

connecting the controller with the membrane-style touch switch assembly.

8. The method described in claim 7, wherein the controller is a digital circuit.

9. The method described in claim 7, wherein the sequence is adapted to highlight the logical control sequence for a particular application.

10. A method for guiding a person in utilizing a device, the method comprising:

connecting a membrane-style touch switch with the device, the membrane style touch switch being adapted to control the device, the membrane-style touch switch including indicator points relating to the control of the device, the membrane-style touch switch further including electroluminescent lighting, the electroluminescent lighting corresponding to at least some of the indicator points; and,

leading the person through a logical sequence for controlling the device by illuminating the membrane-style touch switch using the electroluminescent lighting in such a manner as to illuminate in a sequence the indicator points the person would touch in following the logical control sequence for the device.

FIGURE 1

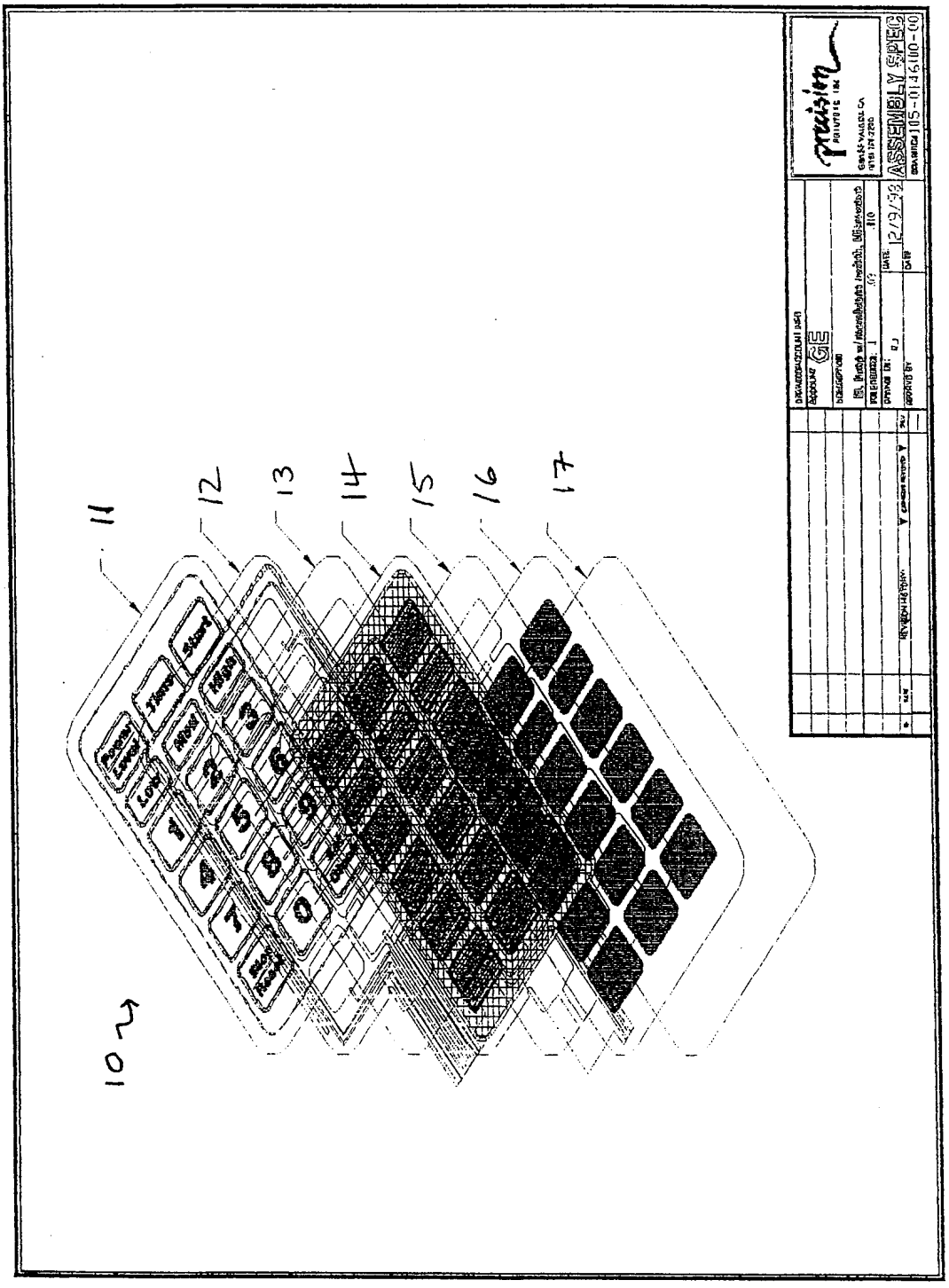
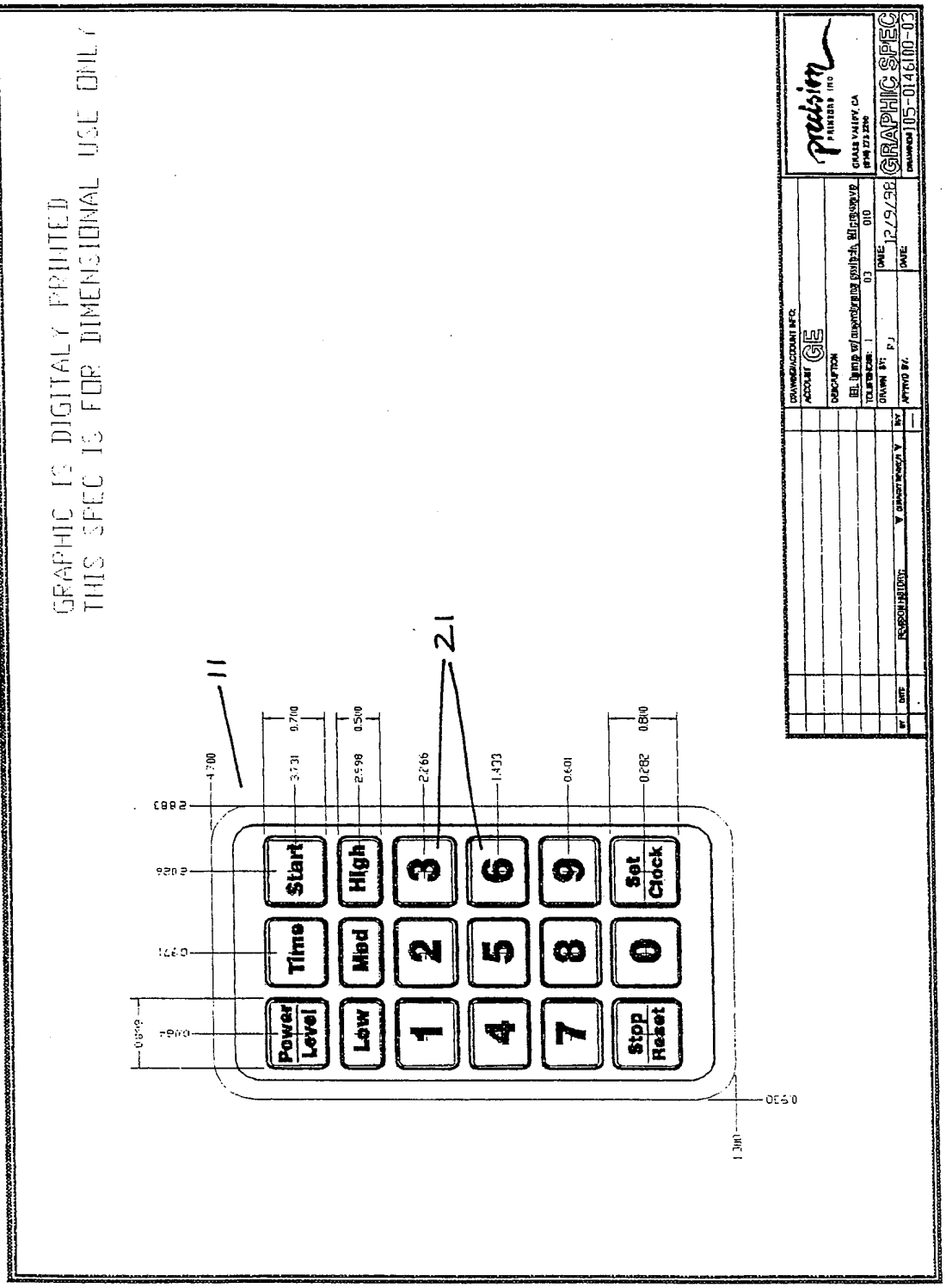


FIGURE 2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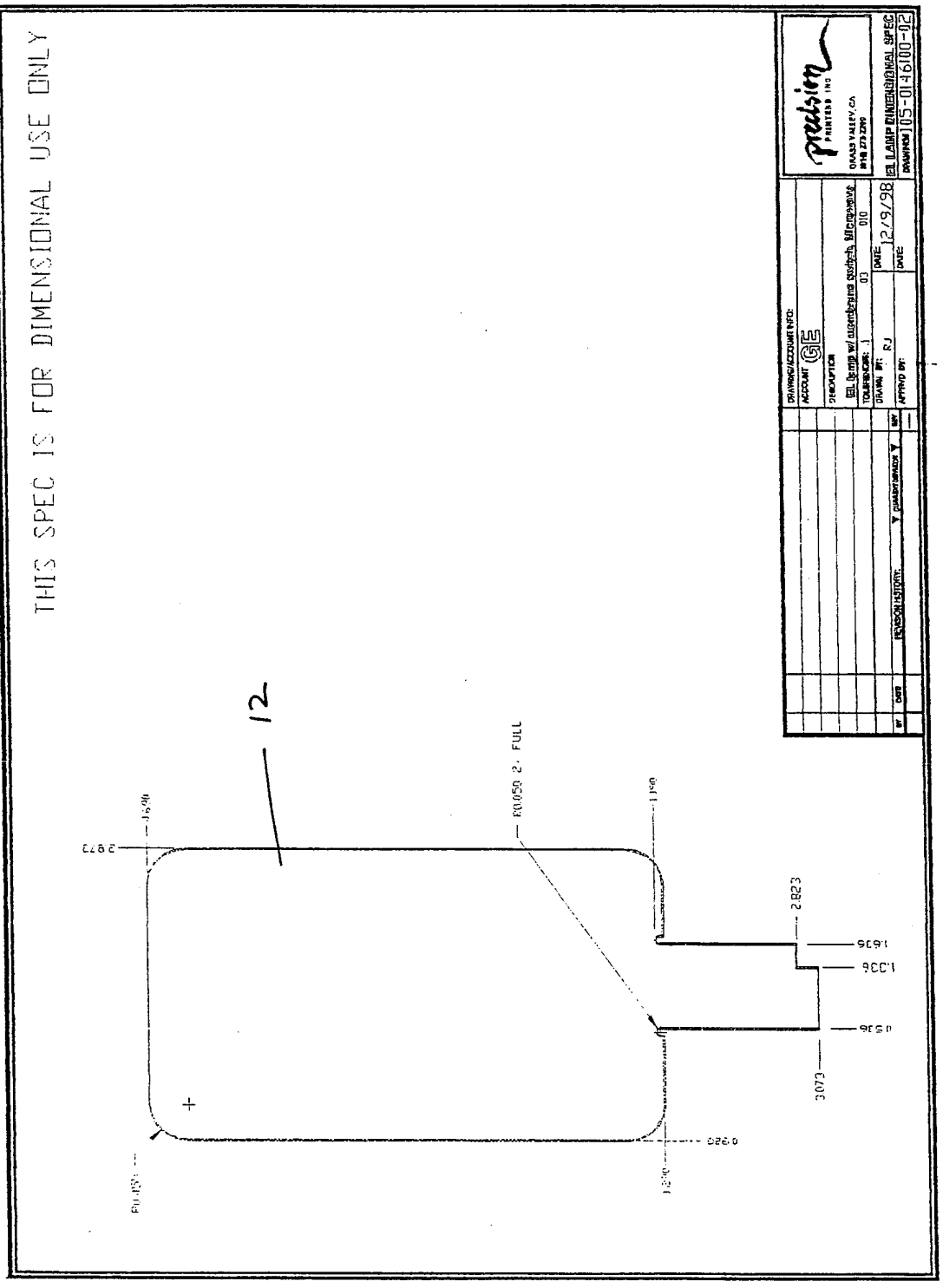
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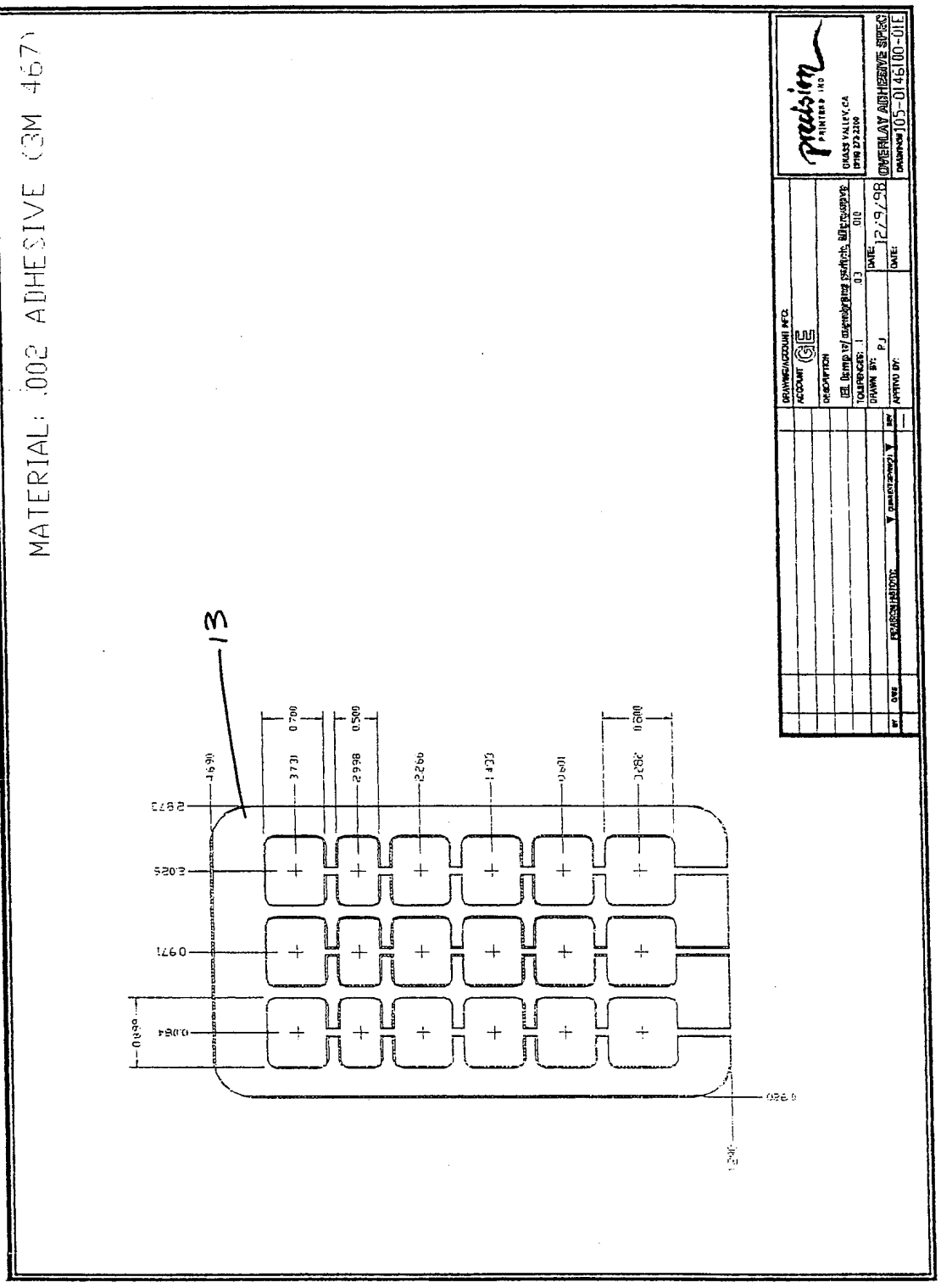
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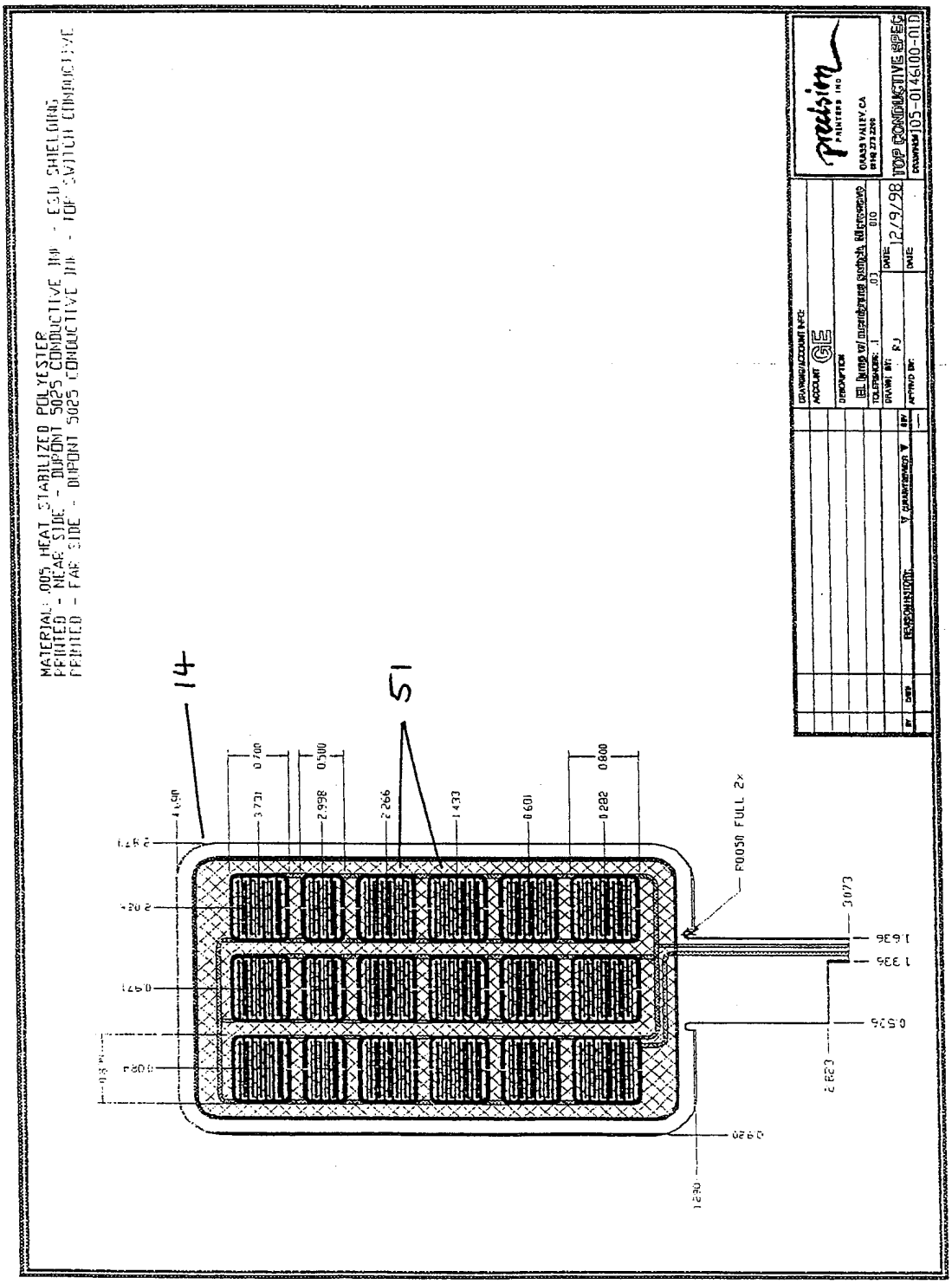
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FIGURE 5

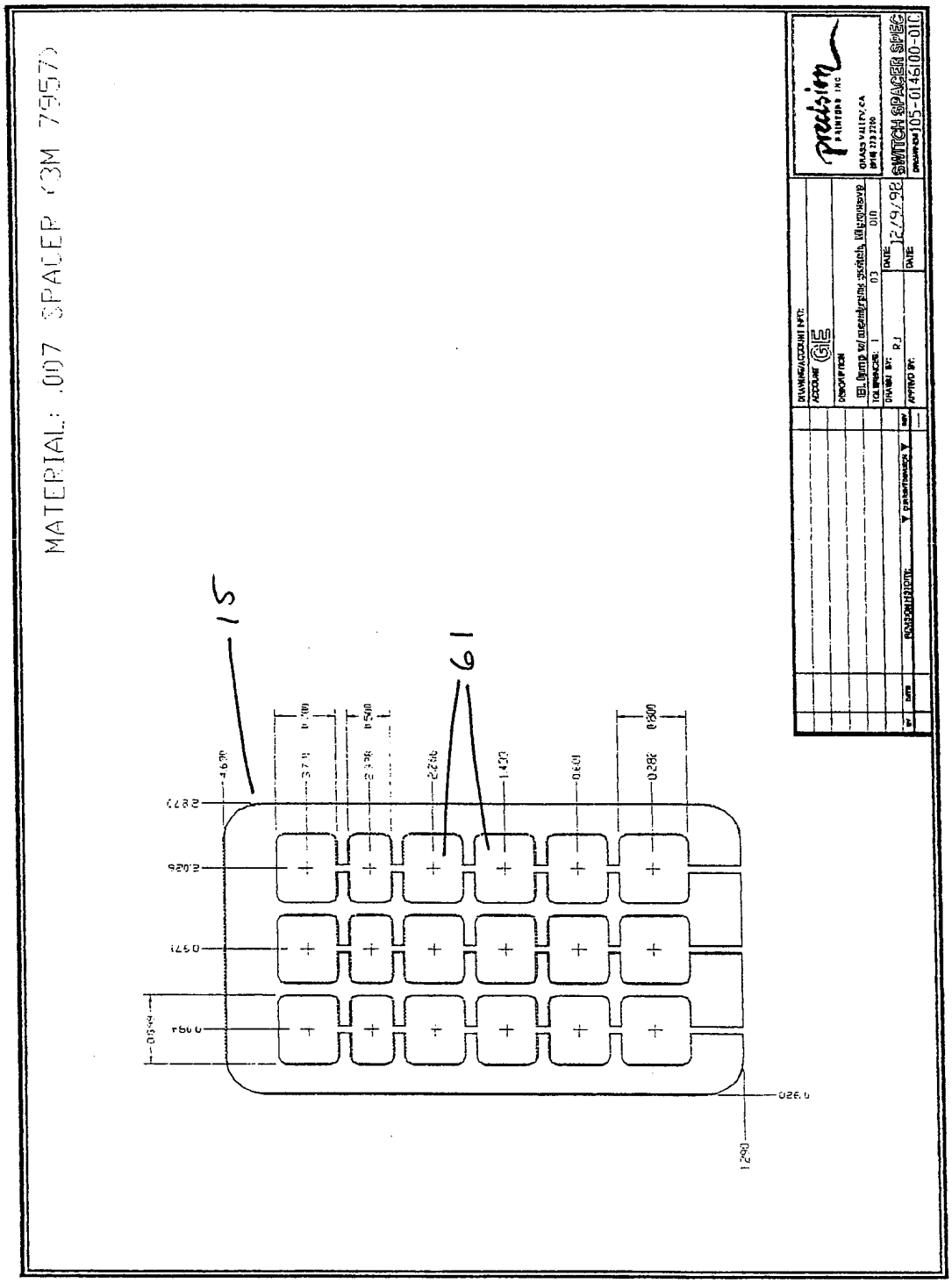
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FIGURE 6

FIGURE 7

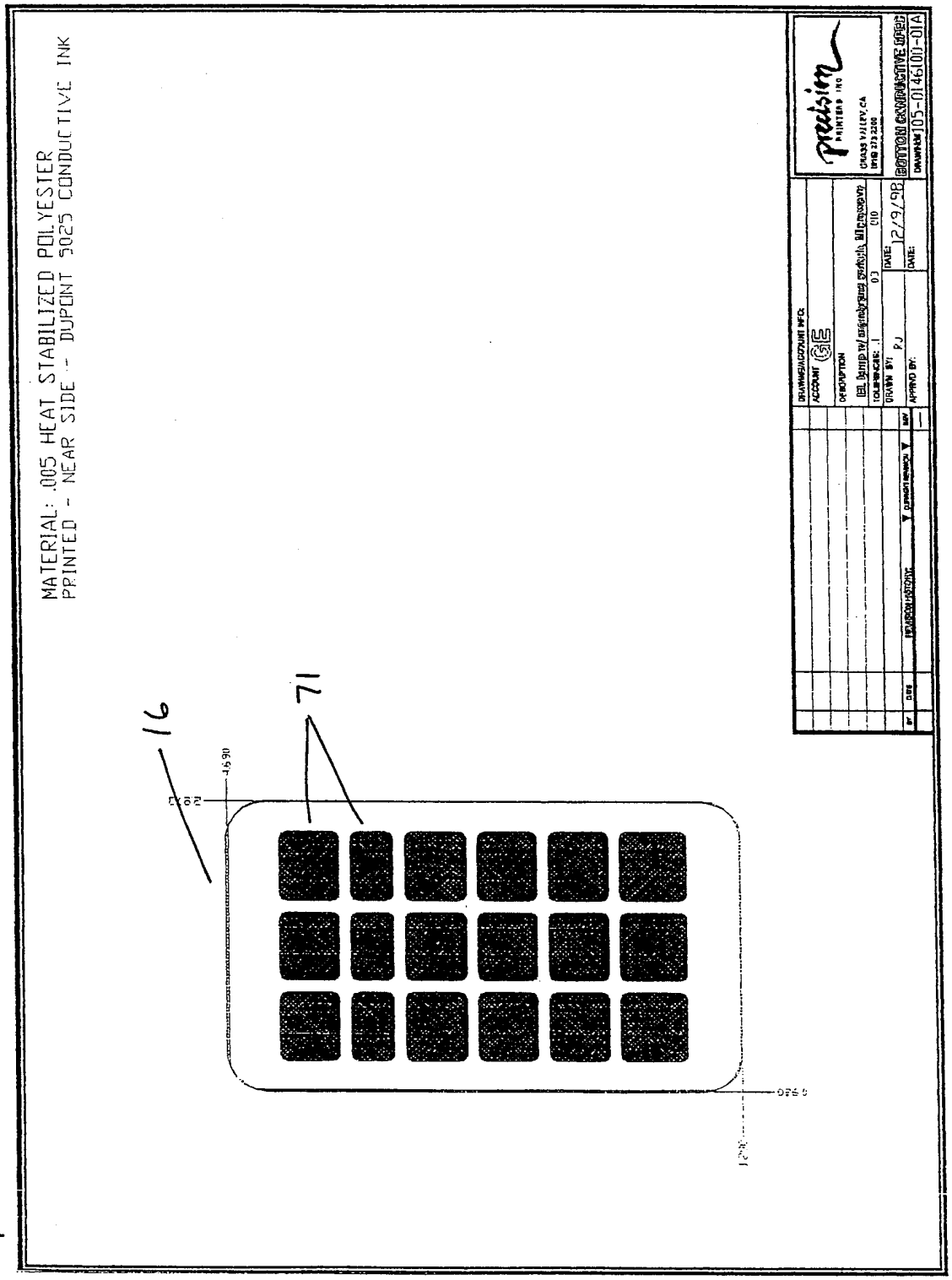
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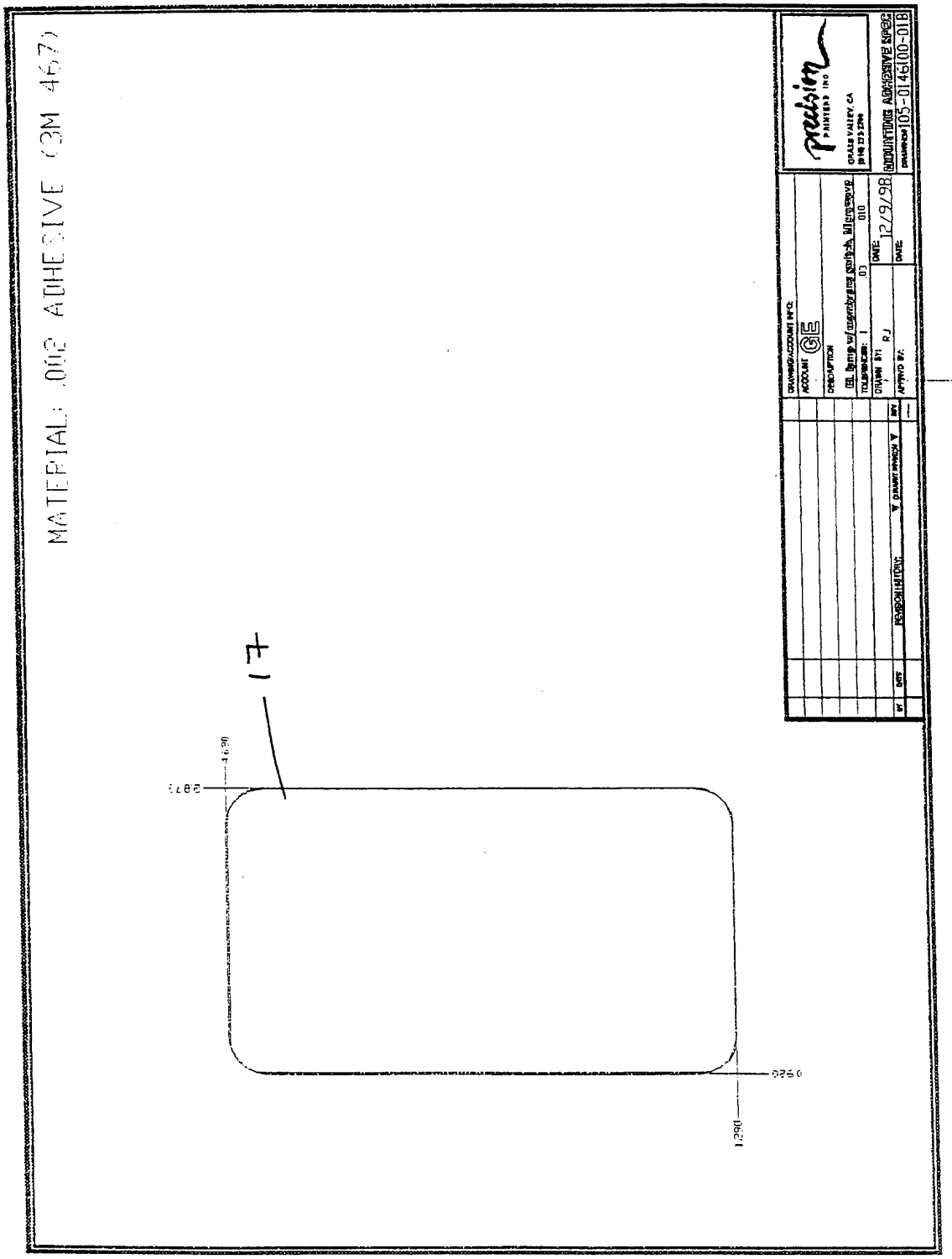
FIGURE 8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DATE
MOUNTING ADHESIVE SPEC
DRAWING 105-01451 00-01B
REVISION HISTORY
BY DATE DESCRIPTION REV

Instructional Keypad

Fig 9

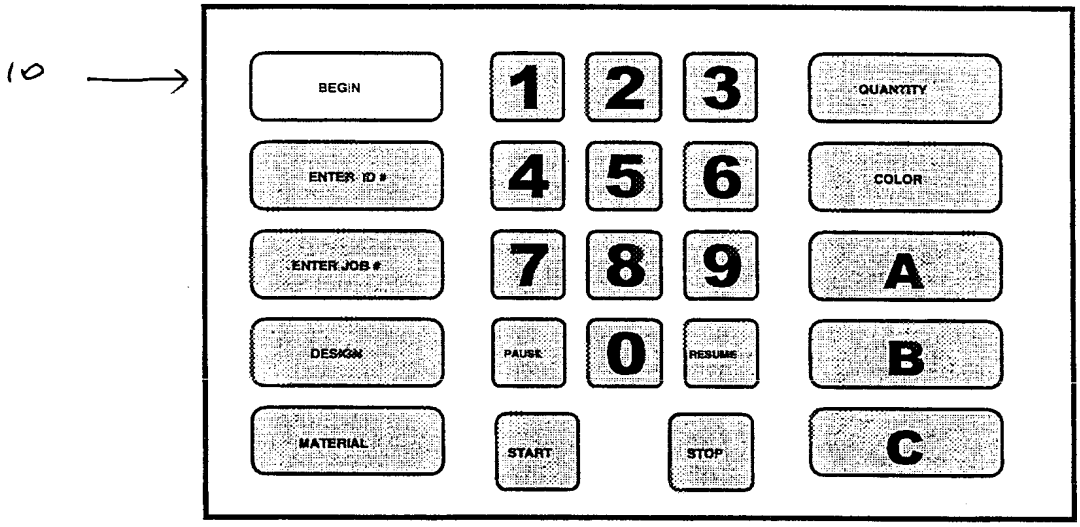
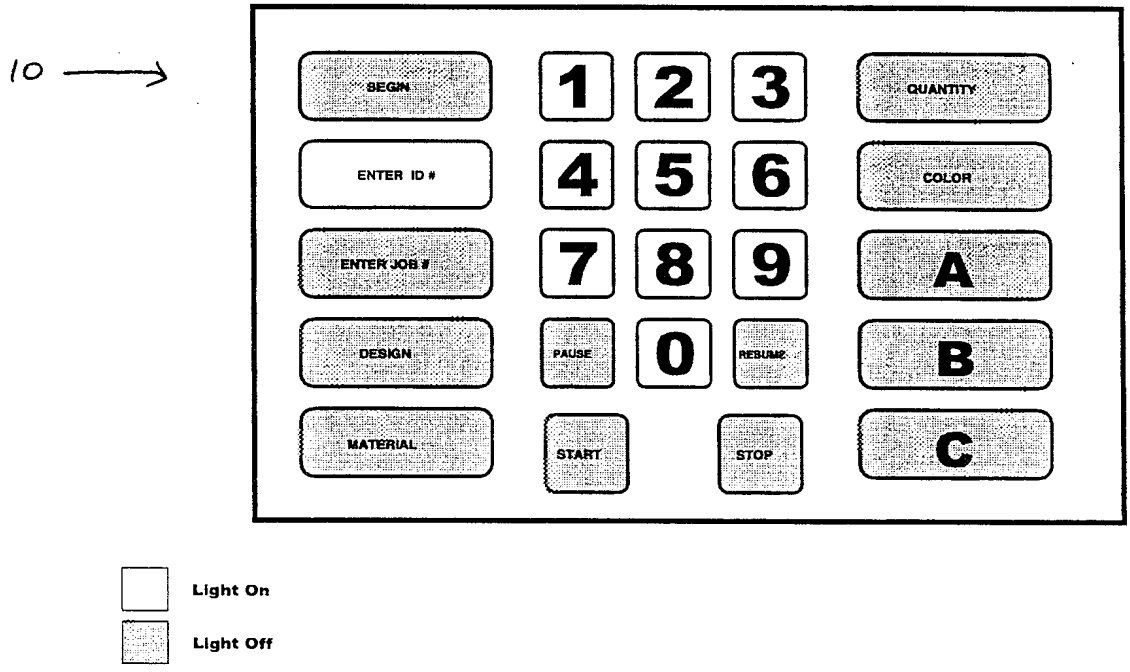


Fig 10



Instructional Keypad

Fig 11

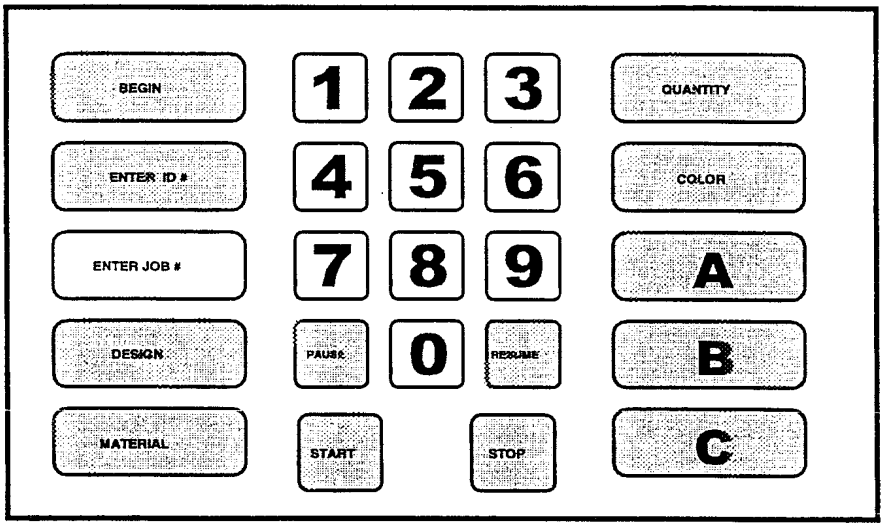
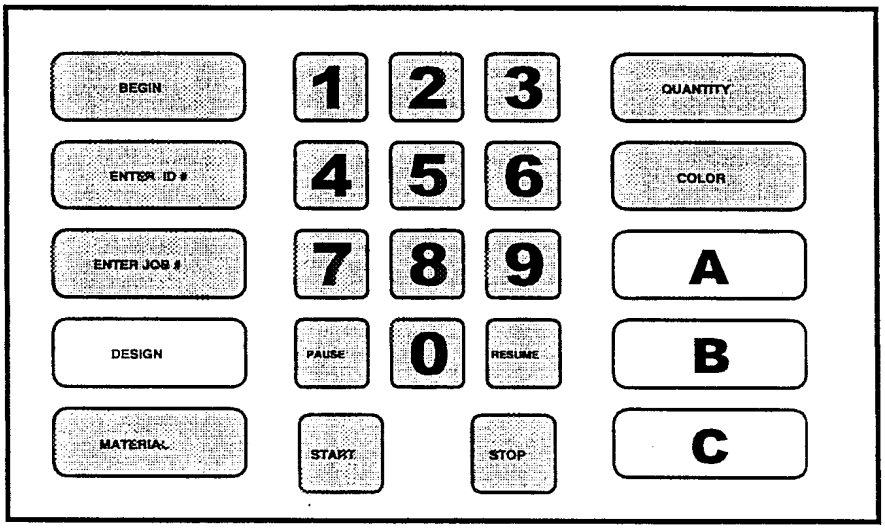


Fig 12



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Instructional Keypad

Fig 13

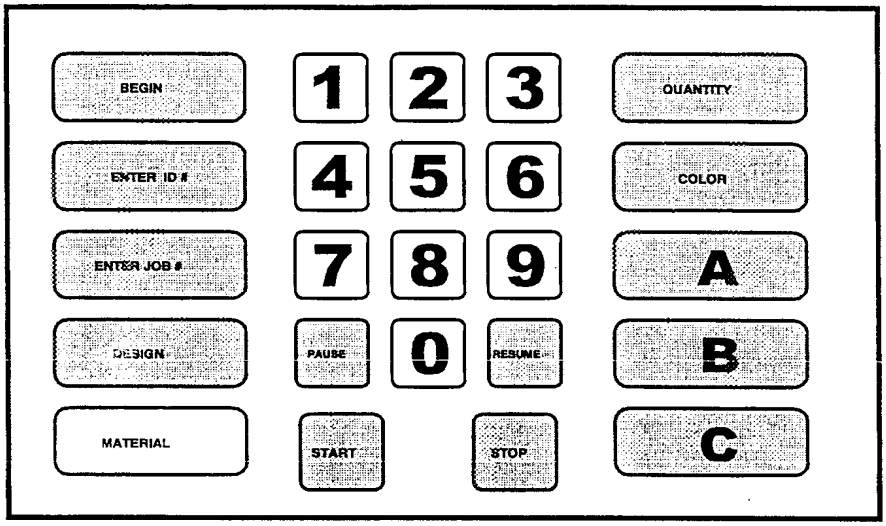

Fig 14

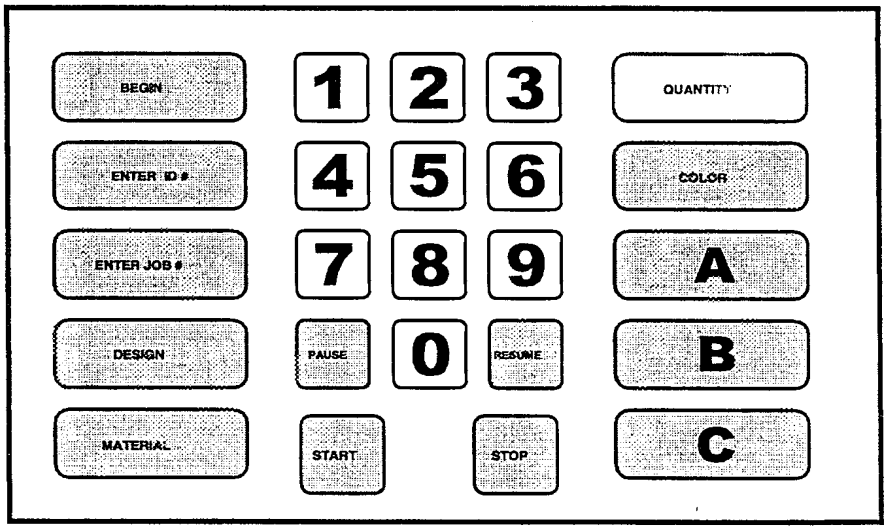

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Fig 15

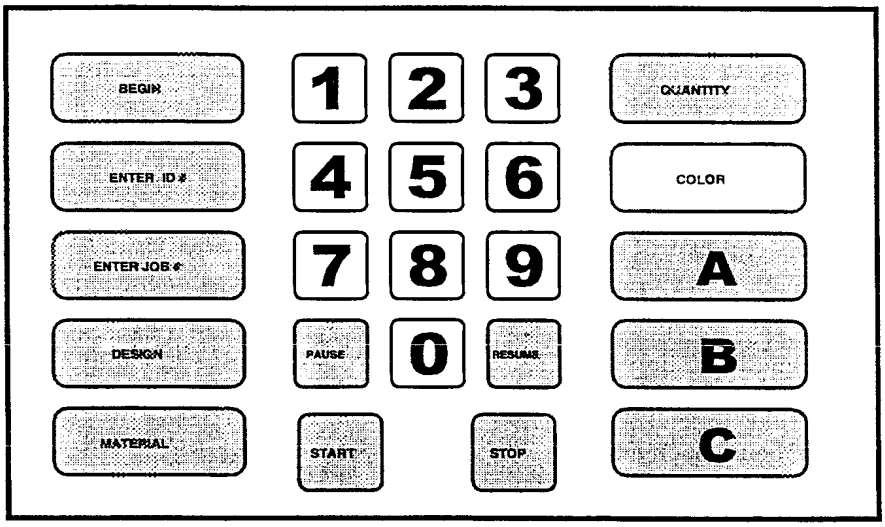
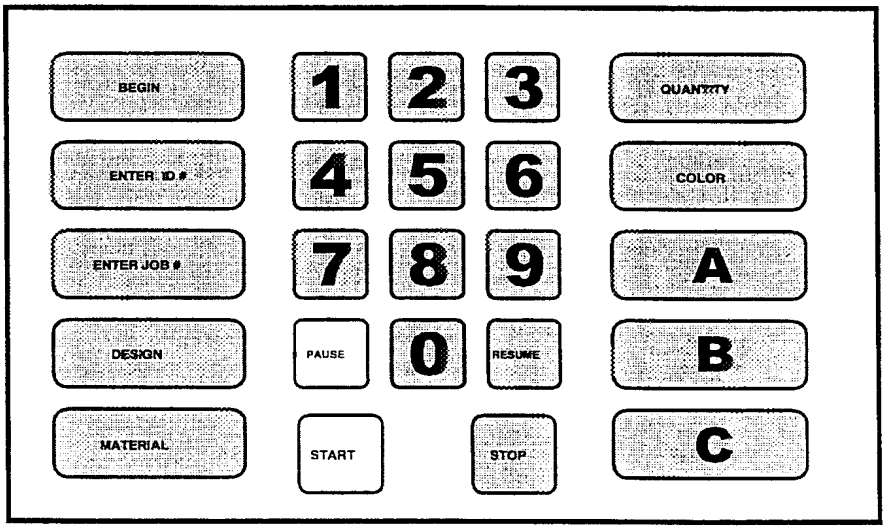


Fig 16



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Instructional Keypad

Fig 17

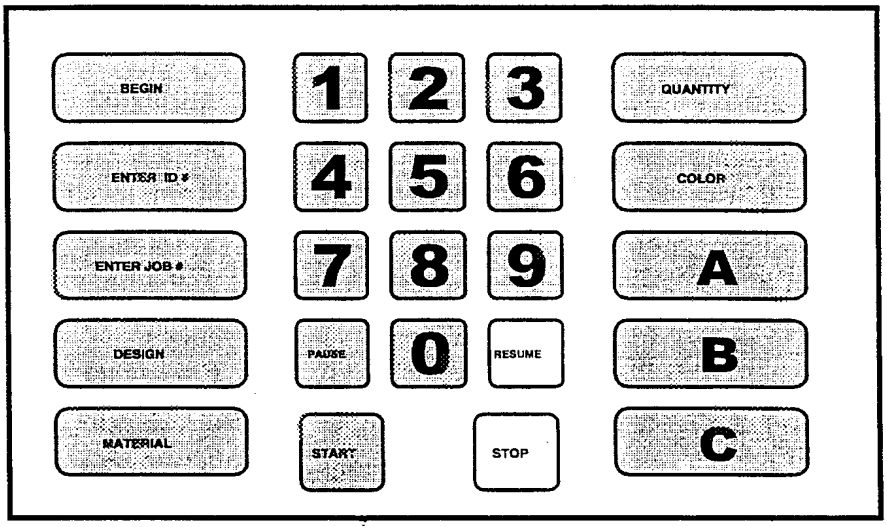
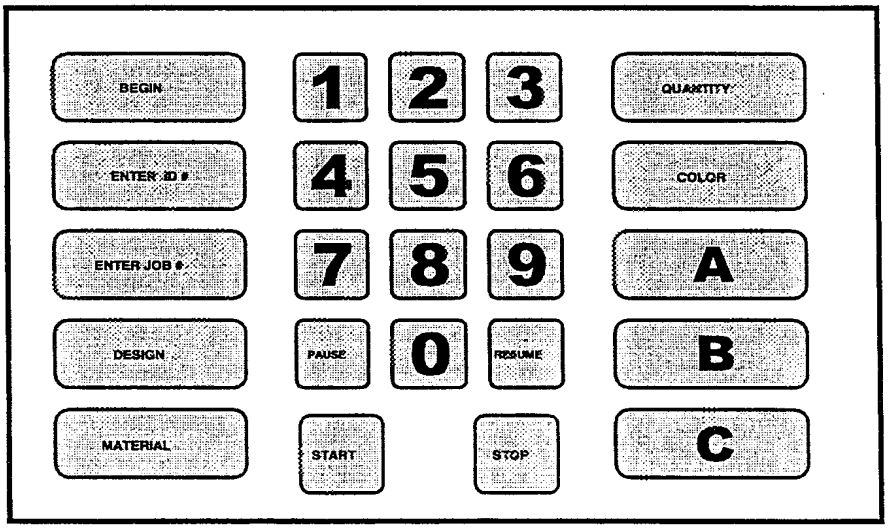


Fig 18



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/06608

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H01H 9/16
US CL : 200/5A, 512

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 200/5A, 512

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,532,395 A (ZUKOWSKI) 30 July 1985 (30.07.1985), see entire document.	1-6
Y	US 3,777,222 A (HARRIS) 04 December 1973 (04.12.1973), see entire document.	1-6
Y	US 4,022,993 A (SHATTUCK) 10 May 1977 (10.05.1977), see entire document.	1-6
Y	US 4,158,115 A (PARKINSON et al.) 12 June 1979 (12.06.1979), see entire document.	1-6
Y	US 4,056,699 A (JORDAN) 01 November 1977 (01.11.1977), see entire document.	1-6
Y	US 4,317,011 A (MAZURK) 23 Febuary 1982 (23.02.1982), see entire document.	1-6
Y	US 4,478,666 A (OGDEN) 23 October 1984 (23.10.1984), see entire document.	1-6
Y	US 4,347,416 A (OGDEN) 31 August 1982 (31.08.1982), see entire document.	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 June 2000 (09.06.2000)	23 AUG 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No.	Authorized officer Nhung Nguyen Telephone No. (703)305-0422

Form PCT/ISA/210 (second sheet) (July 1998)